

LEVEL II

REPORT NO. NADC-80076-60



12

ADA087267

EFFECT OF OXIDIZING FUELS ON AIRCRAFT FUEL SYSTEM ELASTOMERS AND SEALANTS

C. Nadler
Aircraft and Crew Systems Technology Directorate
NAVAL AIR DEVELOPMENT CENTER
Warminster, Pennsylvania 18974

20 May 1980

FINAL REPORT
NAVAIRPROPEN Work Request N6237676WRTD107
Work Unit Assignment 4P7-429

DTIC
ELECTE
JUL 30 1980
S D E

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

Prepared for
NAVAL PROPULSION TEST CENTER
Trenton, NJ 08628

80 7 25 157

DC FILE COPY


NOTICES

REPORT NUMBERING SYSTEM - The numbering of technical project reports issued by the Naval Air Development Center is arranged for specific identification purposes. Each number consists of the Center acronym, the calendar year in which the number was assigned, the sequence number of the report within the specific calendar year, and the official 2-digit correspondence code of the Command Office or the Functional Directorate responsible for the report. For example: Report No. NADC-78015-20 indicates the fifteenth Center report for the year 1978, and prepared by the Systems Directorate. The numerical codes are as follows:

CODE	OFFICE OR DIRECTORATE
00	Commander, Naval Air Development Center
01	Technical Director, Naval Air Development Center
02	Comptroller
10	Directorate Command Projects
20	Systems Directorate
30	Sensors & Avionics Technology Directorate
40	Communication & Navigation Technology Directorate
50	Software Computer Directorate
60	Aircraft & Crew Systems Technology Directorate
70	Planning Assessment Resources
80	Engineering Support Group

PRODUCT ENDORSEMENT - The discussion or instructions concerning commercial products herein do not constitute an endorsement by the Government nor do they convey or imply the license or right to use such products.

APPROVED BY:


R. J. STURM
CLR USN

DATE:

20 May 1980

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NADC-89076-68	2. GOVT ACCESSION NO. AD-A087267	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Effect of Oxidizing Fuels on Aircraft Fuel System Elastomers and Sealants	5. TYPE OF REPORT & PERIOD COVERED Final Report	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) C. Nadler	8. CONTRACT OR GRANT NUMBER(s) 20 May 80	9. PROGRAM ELEMENT PROJECT, TASK AREA & WORK UNIT NUMBERS NAVAIRPROPGEN Work Request N6237676WRTD107 Work Unit Assignment 4P7-429
10. PERFORMING ORGANIZATION NAME AND ADDRESS Aircraft & Crew Systems Technology Directorate Naval Air Development Center Warminster, Pennsylvania 18974	11. CONTROLLING OFFICE NAME AND ADDRESS Naval Propulsion Test Center Tranton, NJ 08628	12. REPORT DATE 20 May 1980
13. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	14. SECURITY CLASS. (of this report) UNCLASSIFIED	15. NUMBER OF PAGES 18
16. DISTRIBUTION STATEMENT (of this Report) Approved for Public Release; Distribution Unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Jet fuels Elastomers Oxidizing fuels BETWEEN		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Jet fuels containing peroxides resulting from hydrogenation during refining have potential for damaging fuel system elastomeric components. Immersion tests were conducted for 1000 hours @ 130 - 165 F in JP-5 containing 1, 5, and 10 meq. peroxide/1000 gm fuel with various fuel system sealants and elastomers. Damage thresholds were indicated and maximum allowable peroxide contents were recommended.		

DD FORM 1473
1 JAN 73EDITION OF 1 NOV 68 IS OBSOLETE
S/N 0102 LP 014-4601

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

TABLE OF CONTENTS

	<u>Page</u>
LIST OF TABLES	ii
BACKGROUND	1
EXPERIMENTAL PROCEDURES	1
MATERIALS	1
TEST METHODS.	1
TEST RESULTS AND DISCUSSION.	2
CONCLUSIONS.	6
RECOMMENDATIONS.	7
REFERENCES	7
ACKNOWLEDGMENT	7

Accession for	
NTIS GRA&I	<input checked="" type="checkbox"/>
DDC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	<input type="checkbox"/>
By _____	
Distribution / _____	
Availability Codes	
Dist	Avail and/or special
A	

LIST OF TABLES

<u>Table</u>	<u>Title</u>	<u>Page</u>
I	Materials and Immersion Test Scheme	8
II	Immersion of Elastomers in JP-5/Peroxide Fue's.	9
III	Immersion of Fuel Tank Sealants in JP-5/Peroxide Fuels.	10
IV	Immersion of Fuel Tank Baffle Material in JP-5/Peroxide Fuels .	11

BACKGROUND

The presence of peroxides in JP-5 fuel has been related to the failure of a neoprene diaphragm located in the high pressure pump in the TF41-A-2 engine. Examination of the fuel used by the aircraft showed the presence of peroxides which can detrimentally affect the life of the neoprene diaphragm. It is believed the peroxides result from a hydrogen treatment during the refining process which is used by several producers throughout the world. The hydrogen treatment may remove the naturally occurring anti-oxidants which normally prevent peroxides from forming in fuels refined by other methods. A few incidents of elastomer deterioration by peroxide containing aircraft fuels have previously been found in Europe as reported in reference (a).

The present investigation was conducted to ascertain any detrimental effects of peroxide containing jet fuels on various type elastomers and sealants used in aircraft fuel systems and to find a safe permissible peroxide level as a requirement in fuel specifications. This study was sponsored by the Propulsion Technology and Project Engineering Department, Naval Air Propulsion Center (NAPC), Trenton, NJ.

EXPERIMENTAL PROCEDURE

MATERIALS

The materials subjected to immersion tests are listed in Table I. The standard elastomers conformed to USAF Specification Bulletin 539. The fuel tank sealants are representative of those currently used in naval aircraft. The reticulated polyurethane foam is installed in fuel tanks as an explosion suppressant. The HMG diaphragm material consists of two layers of woven Fortisan (rayon) impregnated and coated with neoprene elastomer. The final coating thickness is approximately 2 mils on each surface. The HMG diaphragm, its neoprene coating compound and the standard neoprene were tested to obtain base line performance information.

TEST METHODS

1. The general immersion test scheme is shown in Table I.
2. Fuels - a naturally occurring peroxide (hydroperoxide) concentrate, 145-185 meq. peroxide/1000 gm. JP-5 fuel, extracted from JP-5, was supplied by NAPC and used to prepare the immersion test media. The peroxide concentration was determined and monitored during the immersion tests using an analytical method developed by NAPC. The procedure involved a colorimetric potassium iodide reaction which was measured with a Bausch & Lomb Spectronic-20 Spectrophotometer and uniquely required only 0.05 to 0.5 cc of fuel sample. Peroxide concentrations were maintained within $\pm 10\%$ tolerance. Duplicate test specimens of each material were immersed in 200 cc of fuel.
3. Immersion Period - a continuous immersion for 42 days was conducted with daily visual inspections and physical property measurements at 7, 14, 28, and 42 day intervals.

4. Physical Property Tests - the test methods employed were of a screening nature to detect any gross damaging effects by the oxidizing fuels. Duplicate looped configuration specimens of the elastomers and cured sealants (MIL-S-8802) were prepared from 2-inch long X 0.5 inch wide X 0.075 inch thick strips of material folded in half lengthwise and stapled midway with a stainless steel staple. The one-inch long stressed loop area above the staple was examined for cracks or crazing during the immersions using 15X magnification. Shore A durometer hardness was determined on the flat tail section of the loop specimen. Specimens were plied to 1/4 in. thickness for the hardness readings. Volume and weight changes were also obtained on the loop specimens. Channel sealants were applied in 1/16 in. thickness to 1 in. by 2 in. aluminum alloy panels. Visual and manual examination for changes in hardness and adhesion were performed. Weight and volume changes were also measured. All immersion tests were conducted in accordance with ASTM Method D471-72, "Standard Method of Test for Change in Properties of Elastomeric Vulcanizates Resulting from Immersion in Liquids."

Change in tear strength of the polyurethane foam was determined in accordance with the procedures of Specification MIL-B-83054A(USAF) and ASTM Method D1564-71 Suffix G, "Standard Methods of Testing Slab Flexible Urethane Foam."

TEST RESULTS AND DISCUSSION

1. Neoprene Elastomers

Results of immersion tests on various elastomers and the HMG diaphragm material are shown in Table II. The neoprene diaphragm material was only lightly oxidized by 1 meq. peroxide as indicated by surface dulling after 42 days immersion. At 5 meq. peroxide, surface dulling occurred within 14 days and subsequently some light pitting. At 10 meq. peroxide heavier attack occurred and cracking of the neoprene coating initiated within 28 days immersion. Deterioration increased with continued immersion up to 42 days at which time the coating appeared weakened and could be removed by light fingernail scraping.

Looped specimens of the HMG coating compound prepared from 0.075 in. thick sheets exhibited similar surface effects; i.e., dulling and pitting, as the HMG diaphragm but to a lesser degree. Very little cracking occurred. Due to the large difference in surface area to rubber volume ratios (0.002 in. film vs. 0.075 in. sheet) deterioration and cracking is most likely to occur first in the thin neoprene film. Table II hardness data shows 1 meq. peroxide produced little change. At 5 and 10 meq. peroxide a slight softening trend occurred in the swollen state indicative of some decomposition in the basic neoprene structure. In the dry state after 42 days immersion, all media caused a net hardening. Hardening with and without peroxide is caused by extraction of processing oils, waxes and antioxidants known to be present in the HMG neoprene compound. Table II data shows approximately a 5% weight loss after immersion.

The standard neoprene compound (CR) exhibited surface dulling and pitting in the JP-5/peroxide fuels similar to the HMG neoprene compound. Additionally,

a pimpled surface appeared which increased with increasing peroxide content, particularly at 5 and 10 meq. concentrations. This is believed due to an oxidation reaction. Cracking was not evident. The standard neoprene formulation differs from the HMG neoprene in polymer type, and content of fillers (carbon black, clay) and extractable oils and waxes. Reaction to the fuel media may therefore differ with regard to swelling, hardness and degree of oxidation. Hardness data show the oxidizing fuels at 5 and 10 meq. peroxide concentration caused a considerable softening trend in the swollen state compared to the JP-5 control which is indicative of a decomposition effect. This was also shown in the dry state after 42 days immersion. The less obvious softening of the HMG neoprene compound compared to the standard neoprene (CR) may be attributed to the known greater filler and extractables content of the HMG compound which would tend to mask softening due to neoprene polymer decomposition. Hardness changes in elastomers can be indicative of changes in physical properties such as tensile strength, elongation and tear strength, but measurement of physical properties is preferred.

An interesting phenomenon was found regarding the peroxide concentration of the fuel immersion media used for the HMG neoprene coated fabric and the neoprene coating compound. With all other elastomers and sealants tested herein the peroxide contents tended to decrease as immersion time progressed requiring addition of JP-5/peroxide concentrate to maintain desired peroxide levels. With the HMG materials, the 1, 5 and 10 meq. peroxide media were found to increase to approximately 3.9, 28 and 84 meq. peroxide, respectively, (in the worst cases) when allowed to escalate. The maximum increases usually occurred during the 20 to 30 day immersion time period. The control JP-5 fuel also showed an increase from 0.16 to approximately 0.3 meq. peroxide. Further, JP-5/peroxide fuels without elastomer samples aged at 130°F for 42 days all showed gradual decreases in peroxide content. In general, media containing HMG elastomer samples required almost daily monitoring of peroxide content. Evidently the HMG neoprene elastomer produced a catalytic effect and peroxide content escalation. Certain metals, e.g., copper, are known to have catalytic effect on fuels. Possibly contaminant metallic elements in the elastomer compounding ingredients; i.e., clays, carbon black, oils, waxes or residual copper catalyst used to manufacture neoprene-polymer may be responsible.

2. Nitrile Elastomers

Table II data shows that the nitrile standard elastomers were visibly unaffected except for development of a shiny surface after 42 days immersion. This effect is probably due to light surface oxidation. Cracking was not evident. Hardness data indicate the low nitrile elastomer (NBR-L) was unaffected by 1 meq. peroxide and showed a slight softening trend in the swollen state at 5 and 10 meq. peroxide contents compared to the control. In the dry state hardness did not differ significantly from the controls. Hardness changes of the high nitrile elastomer (NBR-H) in all JP-5/peroxide fuels were equivalent to the controls indicating no ill effects. In the dry state a very minor hardening trend mostly at 5 and 10 meq. peroxide contents appeared. It should be noted the NBR-H elastomer is much more fuel resistant than the NBR-L elastomer and has considerably less volume swell and fuel absorption as shown in Table II.

Nitrile seals for aircraft tend to be fabricated from medium to high nitrile elastomers rather than NBR-L. Components such as nitrile coated diaphragms may be more susceptible to oxidative physical changes in view of the high surface area to volume ratio. The nitrile and neoprene elastomers are known to be susceptible to oxidation, consequently antioxidants are generally incorporated in their manufacture. Effectiveness of the antioxidants would depend upon the degree of their fuel extractability. From a functional standpoint, size and shape of an elastomeric component and its operating stresses may also influence the effects of an oxidizing medium.

3. Fluorocarbon and Fluorosilicone Elastomers

Table II data indicates the standard fluorocarbon elastomer (F-A) immersed at a higher temperature, 165°F, in 10 meq. peroxide fuel exhibited no significant visible or hardness changes compared to the control. The fluorosilicone elastomer (FS) behaved similarly except for a minor hardening trend. Note that peroxides are used to vulcanize the FS elastomer. Both the F-A and FS elastomers are known to be highly fuel and oxidation resistant.

Immersion of these elastomers was first attempted at 200°F, but the 10 meq. peroxide content decreased so rapidly it could not be practically maintained; 165°F was the next highest temperature at which the 10 meq. peroxide concentration could be practically maintained.

4. Polysulfide Cured Sealants (MIL-S-8802)

Test results on the elastomeric MIL-S-8802 sealants are given in Table III. After 42 days in 10 meq. peroxide fuel the chromate cured PR-1422B-2 sealant showed significant softening compared to the control, 56 vs. 65 Shore A, respectively, in the dry state which is indicative of a sealant degradation effect. A comparative manual tear strength examination also indicated some loss in strength due to the peroxide fuel exposure. The manganese dioxide cured PR1440B-2 after 42 days immersion also showed a net softening compared to the control, 51 vs. 61 Shore A, respectively, in the dry state. The peroxide-fuel also caused a tacky surface and loss in tear strength. Note the PR1440B-2 control specimen increased in hardness after immersion (55 to 61 Shore A) probably due to extraction of plasticizer which is used with the manganese dioxide curing agent. The sample exposed to peroxide-fuel did not follow the control's behavior and softened instead (51 Shore A) indicating a degradation effect. Subsequently, one specimen of PR1440B-2 was subjected to additional immersion in 10 meq. peroxide fuel for a total of 56 days. Hardness decreased further to 45 Shore A and the sealant surface further degraded to a semi-fluid condition along with other changes indicated in Table III. This degradation is attributed to a reversion effect caused by polymer chain and/or crosslink scission. Polysulfide polymers are susceptible to attack by acid catalyzed hydrolysis at the backbone formal linkage. Only trace amounts of water are needed. Sulfur, mercaptans and strong bases under proper conditions may also cause polymer degradation at the disulfide linkage. This mode is unlikely in view of the good performance of the control sealant. Since periodic additions of fresh peroxide fuel concentrate were required to maintain

10 meq. peroxide it was of interest to ascertain if the peroxide, or strictly hydroperoxide degradation products could result in acidic build-up in the immersion fluids. Acid number analysis, performed by NAPC, on the PR1440B-2 immersion media were as follows:

- a. JP-5 control - 0.007 after 42-day immersion
- b. JP-5/10 meq. peroxide - 0.028 - 0 days immersion
- c. JP-5/10 meq. peroxide - 0.043 after 42-day immersion
(JP-5 specification limit MIL-T-5624 - 0.015 (max.))

The data indicates acidic constituents of the peroxide fuel exceeded both the JP-5 control value and specification limits and may have contributed to sealant degradation. Preparation of the original JP-5/peroxide concentrate may also have caused some acidic buildup. Another polysulfide degradation route is by direct oxidation at the formal linkage but this usually occurs at temperatures around 300°F. The polysulfides are generally considered to have good oxidation resistance at temperatures below 200°F. They are also cured by inorganic and organic oxidizing agents. From the available data it is uncertain whether catalyzed oxidation or acid catalyzed hydrolysis at the formal linkage is the primary degradation process. The latter mechanism is favored. From a practical standpoint, assessment of the acid number of peroxide fuels in aircraft fuel tanks, particularly where stagnant fuel resides, would be of interest to further determine the potential for sealant degradation.

5. Non-Curing Channel Sealants

Table III test data on the polysulfide, cyanosilicone and fluorosilicone mastic type sealants indicate they were not significantly affected by the 10 meq. peroxide fuel immersion. From a cursory manual examination it appeared the polysulfide sealant immersed in peroxide fuel had undergone a slight change by becoming somewhat softer and cackier than the control after 42 days immersion. This behavior may possibly be analogous to that found with the cured type polysulfide sealants. It should be noted that channel sealants are manufactured with a high degree of tack to achieve adhesion.

6. Polyurethane Foam - Fuel Tank Baffle (MIL-B-83054A)

Results of immersion tests are given in Table IV. Tear strength determinations indicate the 10 meq. peroxide fuel did not produce any adverse effects in comparison with the control fuel. Both fuels caused about a 15% decrease in tear strength.

Although not indicated by the results herein, it should be noted the polyurethane foam is susceptible to degradation by hydrolysis which can be accelerated by an acidic medium. In this regard, high acid number peroxide fuels would be undesirable.

C O N C L U S I O N S

From the 1000 hour screening immersion tests with JP-5/peroxide fuels conducted herein, the following is concluded:

1. Serious damage thresholds for the HMC diaphragm are estimated as follows:

1 meq. peroxide	1000 hours
5 meq. peroxide	670 - 1000 hours
10 meq. peroxide	35 - 670 hours

Dynamic operating conditions can be expected to shorten these damage thresholds.

2. The standard neoprene elastomer (CR) behaved similarly to the HMC neoprene material.
3. In general, thin elastomeric films (e.g., diaphragms) would be more readily deteriorated by oxidizing fuel than comparatively thick elastomer items (e.g., O-rings).
4. Low and high nitrile elastomers (NBR-L, NBR-H) were relatively unaffected by 1 meq. peroxide fuel during the 1000 hour exposures. At 5 and 10 meq. peroxide levels the NBR-L elastomer is susceptible to a very mild oxidative attack manifested by minor softening. The NBR-H appears more resistant and only showed a tendency to slightly harden after the 1000 hour exposure. In general, the observed effects are not believed indicative of major changes in the physical strength properties of the NBR elastomers.
5. Fluorocarbon and fluorosilicone elastomers are highly resistant to 1-10 meq. peroxide fuels and remained essentially unchanged. Higher levels or peroxide may be well tolerated.
6. MIL-S-8802 elastomeric polysulfide sealants, particularly manganese dioxide cured type, are prone to severe degradation in 10 meq. peroxide fuel (1000-1350 hrs.) where the fuel acid number exceeds normal limits. It is uncertain whether a catalyzed direct oxidation or an acidic hydrolysis mechanism is responsible. The latter mode is believed more likely to occur. Elevated fuel acid numbers are believed due to peroxide decomposition by-products possibly present in the original prepared JP-5/peroxide concentrate and additionally accumulated in the stagnant immersion media during the test phase. Data on the effects of lower peroxide concentrations and acid numbers is needed to further assess damage potential with MIL-S-8802 sealants. These tank sealants are intended to provide very long service and are difficult to repair.
7. Polysulfide, cyanosilicone and fluorosilicone non-curing type channel sealants exhibited good resistance to 10 meq. peroxide fuel. The polysulfide sealant was slightly softened but not enough to impair its functioning.
8. The MIL-B-83054A Type I polyurethane foam (tank baffle material) was not significantly affected by 10 meq. peroxide fuel during the 1000 hour exposure period.

9. In general, a 1 to 2 meq. peroxide limit for JP fuels should provide a good margin of safety against serious deterioration of most fuel system elastomers and sealants.

10. Further information on the relationship between peroxide content and acid numbers of fuels would be useful.

R E C O M M E N D A T I O N S

1. The maximum allowable peroxide content of JP fuels be kept in the range of 1 - 2 meq. peroxide/1000 gm. fuel.
2. Conduct immersion studies with MIL-S-8802 sealants to determine the effects of peroxide concentrations below 10 meq. and of fuel acid number variation.
3. Determine the potential for acid number build-up in fuels both in storage and in operating aircraft fuel tanks.
4. Develop an alternate coating for the BMC diaphragm from more fuel and oxidation resistant low temperature elastomers such as fluorocarbon (Viton GLT), fluorosilicone or fluorophosphonitrilic (PNF).

R E F E R E N C E S

- (a) "Fuel Related Problems in Engine Fuel Systems," Love B. E., et al; SAE, Aeronautic Space Engineering and Manufacturing Meeting October 3-7, 1966

A C K N O W L E D G M E N T

The assistance of the Materials Synthesis and Characterization Section in performing the final peroxide content analyses is greatly appreciated.

TABLE I
MATERIALS AND IMMERSION TEST SCHEME

Materials	JP-5/Peroxide Concentration, mg./1000 gm. fuel				Immersion Temperature, °F
	0	1	5	10	
<u>ELASTOMERS</u>					
NBC Diaphragm	X	X	X	X	130
Neoprene-NBC Coating Elastomer	X	X	X	X	130
Neoprene-Standard CR	X	X	X	X	130
Low Nitrile-Standard NBR-L	X	X	X	X	130
High Nitrile-Standard NBR-H	X	X	X	X	130
Fluorocarbon-Standard F-A(Viton A)	X	-	-	X	165
Fluorosilicone-Standard FS	X	-	-	X	165
Polysulfide Sealants - MIL-S-8802					
Chromate Cure	X	-	-	X	130
Manganese Dioxide Cure	X	-	-	X	130
Polyurethane Foam - MIL-B-83054A, Type I	X	-	-	X	130
<u>CHANNEL SEALANTS</u>					
Polysulfide - PR-702	X	-	-	X	130
Cyanosilicone - G250	X	-	-	X	130
Fluorosilicone - DC 94-011	X	-	-	X	130

NADC-80076-60

TABLE II

IMMERSION OF ELASTOMERS IN JP-5/PEROXIDE FUELS

ELASTOMER	HMG Diaphragm Neoprene Coated Fabric					Neoprene Coating Compound-HMG Diaphragm				Neoprene Standard (CR)		
JP-5 Peroxide Content Meq./1000 gm. fuel	JP-5 ⁽¹⁾ Control 1 5 10					JP-5 Control 1 5 10				JP-5 Control 1 5		
Immersion Temperature	130°F					130°F				130°F		
AFTER IMMERSION	- DAYS											
Volume Change, %	7	41.6	35.0	23.6	25.0	41.5	41.0	43.0	41.5	62.5	64.0	70.5
	42	30.0	30.2	19.3		40.3	37.5	31.0	30.0	54.6	57.0	63.5
dried 48 hrs.@ 160°F	42	-0.3	-2.0	-6.6	-6.8	-7.4	-7.3	-7.5	-7.3	1.5	2.0	2.8
Weight Change, %	7	9.2	9.4	10.0	10.2	18.3	18.7	18.7	18.9	33.2	34.0	35.2
	42	9.0	8.6	8.6		16.1	16.3	14.8	14.4	29.0	30.6	33.0
dried 48 hrs.@ 160°F	42	-4.9	-5.6	-4.6	-4.5	-4.8	-4.6	-4.6	-4.7	-0.5	-0.7	-0.5
Hardness, pts. (Shore A)	0	NA(2)				72	72	72	72	72	72	72
	7					58	58	57	57	50	50	47
	14					58	58	57	55	50	48	44
	28					57	57	54	53	48	45	38
	42					57	57	54	53	45	43	36
dried 48 hrs.@ 160°F	42					77	77	78	80	64	63	59
Observations	7	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	14	OK	OK	D	D	OK	OK	OK	D	OK	OK	OK
	28	OK	OK	D	C,P,D (5)	OK	OK	D, few P	D,P	OK	OK	D, PM
	42	OK	D (3)	D,P(4)	incr. D,P,C	OK	few P	D,P	D,P	OK	slt.D	D, PM, P
dried 48 hrs.@ 160°F	42	slt.D	D	D,P	D,P,C (6)	few P	few P	D,P	D,P (7)	slt.PM	slt.D	D, PM, P
									few C	(8)	PM	D

NOTES: (1) no added peroxide; 0.16 meq./1000 gm naturally present

(2) not applicable

(3) D - dulled

(4) P - pits

(5) C - cracks

(6) coating weakened, patches removable

(7) surface hardened

(8) PM - pimply surface

(9) SS - shiny surface

Neoprene Standard (CR)				Low Nitrile Standard (NBR-L)				High Nitrile Standard (NBR-H)				Fluorocarbon Standard (F-A)		Fluorosilicone Standard (FS)	
JP-5 Control 1 5 10				JP-5 Control 1 5 10				JP-5 Control 1 5 10				JP-5 Control 10		JP-5 Control 10	
130°F				130°F				130°F				165°F		165°F	
5	64.0	70.5	67.5	38.5	40.0	41.0	40.5	17.5	15.3	15.2	15.3	1.6	2.1	8.9	9.3
6	57.0	63.5	63.0	32.0	32.6	32.4	31.5	17.8	13.6	13.5	13.9	2.3	4.1	4.5	5.5
5	2.0	2.8	2.5	-0.1	-0.5	2.0	3.5	4.2	3.9	4.5	6.1	1.5	2.4	1.4	0.4
2	34.0	35.2	36.2	24.8	25.8	25.7	27.2	9.2	9.4	9.7	10.1	1.1	1.4	3.2	4.0
0	30.6	33.0	33.0	20.5	21.7	22.6	22.8	11.0	8.6	9.3	9.8		1.4	2.2	2.6
5	-0.7	-0.5	-0.4	-1.7	-1.2	1.4	3.0	1.9	2.1	3.1	4.2	0.6	1.1	-0.2	-0.6
	72	72	72	70	70	70	70	70	70	70	70	73	73	67	67
	50	47	46	55	55	56	53	63	63	62	63	70	69	59	58
	48	44	41	54	55	53	50	63	63	62	63	69	68	58	59
	45	38	33	55	53	50	49	62	62	62	62	69	67	58	61
	43	36	33	55	55	51	51	63	63	62	62	70	70	62	64
	63	59	53	67	67	65	65	66	67	69	70	72	72	64	67
	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	OK	OK	D	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	OK	D, PM	D, PM, P	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	slt. D	D, PM, P	incr.	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
			D, PM, P												
	slt. D	D, PM, P	D, PM, P	slt. D	OK	OK	OK	D	OK	OK,	OK,	OK	OK	OK	slt. D
	PM				slt. SS	SS	> SS			SS	> SS				

NADC-80076-60

TABLE III

IMMERSION OF FUEL TANK SEALANTS IN JP-5/PEROXIDE FUELSELASTOMERIC, CURING TYPE - MIL-S-8802

SEALANT	PR-1422B-2 Polysulfide-Chromate Cure		PR-144CB-2 Polysulfide-Manganese Dioxide Cure		JP-5 Control
	JP-5(1) Control	10	JP-5 Control	10	
Immersion Temperature	130°F		130°F		
<u>AFTER IMMERSION</u>	<u>DAYS</u>				
<u>Volume Change, %</u>					
	7	6.5	6.2	0.4	2.5
	42	2.4	3.3	-0.3	2.5
dried 48 hrs @ 160°F	42	-2.1	-2.6	-7.7	-2.8
<u>Weight Change, %</u>					
	7	1.3	1.8	-1.2	1.6
	42	1.0	1.7	-1.0	1.7
dried 48 hrs @ 160°F	42	-2.4	-1.7	-4.9	-1.1
<u>Hardness</u>	0	67	67	55	NA(2)
(Shore A)	7	61	58	54	-
	14	58	54	53	-
	28	57	56	53	-
	42	58	53	54	-
dried 48 hrs @ 160°F	42	65	56	61	-
<u>Observations</u>					
	7	OK	OK	OK	OK
	14	OK	OK	OK	OK
	28	OK	OK	OK	OK
	42	OK	OK	OK	OK
dried 48 hrs @ 160°F	42	OK	some loss in tear (3) strength	OK	OK
				tacky	slight
				tacky; loss in tear strength	and loss
				very tacky; surface flowed; gummy, weak (4)	
<u>Adhesion to Aluminum</u>	NA(2)		NA	NA	OK

NOTES: (1) no added peroxide; 0.16 meq/1000 gm naturally present
 (2) not applicable
 (3) manual examination
 (4) after 56 days immersion

NON-CURING, INJECTION TYPE CHANNEL SEALANTS

PR-792 Polysulfide		G-250 Cyanosilicone		DC 94011 Fluorosilicone	
JP-5 Control	10	JP-5 Control	10	JP-5 Control	10
130°F		130°F		130°F	
-	-	-	-	-	-
2.5	1.8	1.7	2.2	3.2	3.1
2.5	3.6	3.3	4.2	3.0	3.0
-2.8	-2.2	-2.2	-1.6	-2.1	-2.1
1.6	1.6	1.2	1.5	1.1	1.0
1.7	2.4	2.0	2.5	0.9	0.9
-1.1	-0.5	-1.1	-1.0	-1.8	-1.8
NA(2)	NA	NA	NA	NA	NA
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
OK	OK	OK	OK	OK	OK
OK	OK	OK	OK	OK	OK
OK	OK	OK	OK	OK	OK
OK	OK	OK	OK	OK	OK
slightly harder and less tack	slightly softer and tackier than control	OK	OK, slightly yellowed	OK	OK
(4)					
OK	OK	OK	OK	OK	OK

TABLE IV

IMMERSION OF FUEL TANK RAFFLE MATERIAL IN JP-5/PEROXIDE FUELS

JP-5 Peroxide Content. meq/1000 gm. fuel		Polyurethane Foam MIL-B-83054A, Type I	
		JP-5 (1) Control	10
Immersion Temperature		130°F	
<u>After Immersion-</u>	Days		
Tear Strength, lbs/in	0	7.2	7.2
	7	5.4	5.6
	42	6.4	6.0
Dried 48 hrs @ 160°F	42	5.7	5.9
<u>Observations</u>	42	OK	OK

Notes (1) No added peroxide: 0.16 meq/1000gm naturally present.

NADC-80076-60

D I S T R I B U T I O N L I S T

NAVAIRPROPCEN WORK REQUEST N6237670WRTD107
Work Unit Assignment 427-429

	<u>No. of Copies</u>
NAVAIR (AIR-950D)	6
2 for retention	
1 for AIR (320A)	
1 for AIR (5163)	
1 for AIR (5163D)	
1 for AIR (5163D6)	
NAVAIREWORKFAC, NAS, Alameda (Code 343)	1
Jacksonville (Code 343)	1
North Island (Code 343)	1
Norfolk (Code 343)	1
Pensacola (Code 343)	1
MCAS, Cherry Point (Code 343)	1
Air Force Materials Lab (AFWAL/MLSA)	1
(AFWAL/MLSE)	1
COMNAVAIRLANT (Code 628)	1
COMNAVAIRPAC (Code 7412)	1
DTIC.	12